With the author's kind regards

T. D. A. Doran

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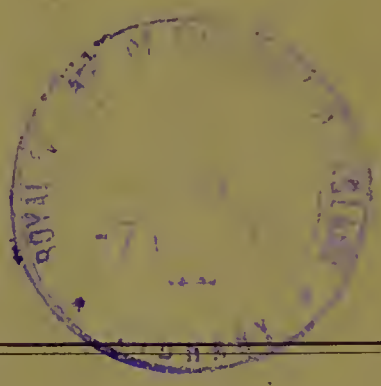

THE BEST AND MOST MODERN METHODS OF THE EXAMINATION OF URINE AS REQUIRED IN MEDICAL PRACTICE.

BY

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THE BEST AND MOST MODERN METHODS OF THE EXAMINATION OF URINE AS REQUIRED IN MEDICAL PRACTICE.

By W. Henry Kesteven, M.R.C.S.

For all practical purposes the important facts required to be determined respecting any given specimen of urine are the following :

I. The amount excreted in a given time.

II. The colour, whether light, normal, dark or coffee-coloured.

III. The specific gravity.

IV. The reaction as determined by litmus or turmeric.

V. The principal constituents of clinical importance, as determined chemically.

VI. The characteristics of the deposit both (*a*) macroscopic, and (*b*) microscopic.

The first four of these points may be said to be determinable at sight, and can therefore be dismissed in a few words. But the determination of the two latter points require considerable attention, for we cannot now-a-days afford to do the examination of urine in the old-fashioned perfunctory style.

(I) THE AMOUNT PASSED IN A GIVEN TIME.

It is convenient for various reasons to let the given time be twenty-four hours. Normally in this period the amount of urine passed is about 50 ounces, but it may vary from ten to fifteen ounces either way without becoming abnormal.

(II) THE COLOUR.

The colour of the urine should be sherry coloured It may be normally a pale or dark shade of that colour. But it is not normal when it is almost colourless, when its yellow tinge becomes brown or reddish brown, olive tinted red, coffee coloured, or black. The colour sometimes depends upon the deposit, and the urine should be allowed to stand long enough for this to settle before its colour is determined. The colour of the deposit will be considered later on.

(III) THE SPECIFIC GRAVITY.

The specific gravity of the urine is normally 1020. This is determined best by urinometers. These instruments should be carefully graduated with their degrees diminishing in size from above downwards, if accuracy of

observation is desired. It is also advisable to use at least four ounces of urine for the purpose and to have a proportionately large urinometer. Those made by Mr. Acland for Messrs. Horne and Thornthwaite, of the Strand, are the best.

(IV) THE REACTION.

This shows the acidity or alkalinity, and should be determined in the ordinary way by litmus or turmeric papers.

(V) THE PRINCIPAL CONSTITUENTS OF CLINICAL IMPORTANCE AS DETERMINED CHEMICALLY.

These are of high importance. For practical purposes we may divide them into the (*a*) normal constituents and (*b*) the pathological constituents.

The normal constituents which require notice by the practitioners are—

1. *Pigmentary Matters.*
2. *Uric Acid.*
3. *Urea.*

The abnormal constituents of clinical importance are—

1. *Albumen.*
2. *Blood.*
3. *Sugar.*

A. NORMAL CONSTITUENTS.

Of these only the latter, urea, absolutely requires the application of chemical tests to decide whether it is in normal proportion to the other constituents. The two latter, uric acid and the pigmentary matters, need not be specially examined unless there is some macroscopic abnormality about them.

(1) PIGMENTARY MATTERS.

Dark coloured or olive tinted urines should be tested for bile. This is done by observing the play of colours produced by adding a drop or two of nitric acid to a thin layer spread on a white porcelain surface.

Indican is one of the pigmentary substances sometimes found in abnormal amounts in the urine, but its source is so highly problematical in the present state of our knowledge, as to remove it from the sphere of practical medicine. It is at present more of the nature of a curiosity, than what can be described as a recognised pathological substance. All that is positively known about it is that the quantity in which it appears in the urine depends sometimes upon the amount of indol which is absorbed by the blood from the intestines, and it has therefore been found in cases of stenoses of the intestinal

canal, which have been the cause of increased intestinal putrefaction. But it has been reported as being found in many other different diseases, in which its presence could in no wise be accounted for.

(2) URIC ACID.

When this substance is present in abnormal quantities it can be detected either by the naked eye or by the aid of the microscope.

(3) UREA.

There have been many methods devised for the determination of the urea in the urine. It is here only intended to mention two of them.

The first and most expeditious is that devised by A. W. Gerrard, of University College. It consists of an arrangement of two glass tubes, one of which slides on the other, and a glass bottle in which the chemical reaction takes place. This latter is connected by a caoutchouc tube with the larger of the two previously mentioned tubes, so as to form one system of vessels by means of which a hydrostatic estimation of the amount of nitrogen set free by the action of a solution of sodium hypobromite on the urine enables the operator to read off a prepared scale the percentage of urea present.

The entire apparatus can be procured at Griffin's, Garrick Street, Covent Garden.

This process is expeditious and practically correct, but it possesses one important disadvantage, at all events for those who wish to employ it frequently. It is expensive.

The hypobromite solution is said to keep good for six months, such has not been my experience. If the bromine and the solution of caustic soda are kept apart in different bottles, there is always a considerable amount of annoyance caused by the bromine vapour which escapes whenever it is used. To meet this latter difficulty Messrs. Griffin sell sealed tubes contained the amount of bromine required for each experiment, but these are necessarily another source of expense.

The other method employed for the estimation of urea is by no means new, nor is it as expeditious as the last mentioned, but it can be relied upon, and after all, does not take so very long.

This test depends upon the formation of a compound insoluble in water, and which is formed by the combination of the urea in the urine with mercuric nitrate added in solution.

Requisites for the Use of this Test—Solution of Mercuric Nitrate.—Dissolve 77.2 grammes of pure dry mercuric

oxide in nitric acid. Evaporate this solution to the consistence of a syrup, and dilute it to one litre with distilled water (each cubic centimetre of solution thus made is equivalent to 0.01 grammes of urea).

Saturated solutions of barium hydrate and barium nitrate.

Bicarbonate of soda papers.

Some crystals of silver nitrate.

A Mohr's burette holding 50 cubic centimetres.

Two or three precipitating glasses.

Small evaporating dish.

Funnel.

Filter papers.

A 10 cc. measure.

The *modus operandi* is as follows: To 20 cc. of the urine add 10 cc. of saturated solution of barium nitrate, and 10 cc. of saturated solution of barium hydrate. These precipitate the sulphates and phosphates. The whole should then be filtered. The chlorides must then be precipitated by adding to the filtered liquid a small crystal of silver nitrate. 20 cc. of the fluid thus treated (= 10 cc. of urine) should be then placed in the evaporating dish or shallow vessel, and the solution of mercuric nitrate which has been previously placed in the burette allowed to drop, one cubic centimetre at a time, into it from the burette. After the addition of each cubic centimetre a drop of the fluid under examination should be placed upon paper soaked with solution of sodium bicarbonate. Immediately one of these drops show a yellow tint on the paper, the operation should be stopped, and the amount of the solution of mercuric nitrate used should be read off. The yellow colour on the paper shows that all the urea in the 10 cc. of urine contained in the shallow vessel has been precipitated, and that there is now no more to prevent the mercuric nitrate producing its characteristic effect upon the soda paper—*i.e.*, from combining with the soda, and so forming the yellow colour seen.

To calculate the amount of urea per 1000 contained in the specimen under examination, it is only necessary to multiply the number of cubic centimetres of solution of mercuric nitrate used by 100. For each cubic centimetre of the solution of mercuric nitrate is equivalent to 0.01 grammes of urea. If 25 cc. of mercuric nitrate solution have been used, the calculation is as follows:

25 cc. mercuric nitrate solution = ·25 grammes in 10 cc. of urine
$.25 \times 100 = 25$ grammes contained in 1000 cc.

So that simply reading off the number of cubic centimetres shown by the burette to have been used, will give the

amount of urea present per 1000 parts of urine. This is the best result that can be obtained from an isolated specimen of urine. If, however, the amount of urine passed in twenty-four hours is known, it is convenient to convert the above expression into grains per ounce, and this is done by multiplying the above result by .4375; the result thus obtained, multiplied by the amount of urine reckoned in ounces, will give the amount of urea voided in twenty-four hours.

25 grammes per 1000 × .4375 = 10.9375 grains per ounce × 24 = 262.5 grains.

B. THE ABNORMAL CONSTITUENTS—(1) ALBUMEN.

Under the head of albumen must be included that form of albumen, the free presence of which in the blood, whether as product of digestion or derived from the absorption of purulent materials, is made evident by the urinary secretion even of the healthy kidney. This substance has received the name of *peptone*, and it is necessary to distinguish between this albuminous body and the albumen of the serum of the blood.

It is claimed for some of the reagents used to detect albumen in the urine that they do not precipitate peptone. With other reagents it is necessary before deciding that every slight cloud rendered apparent in the urine by their use is albumen derived from serum, to make use of the following test, which indicates plainly that peptone is present when that is the case. It was given in the *Lancet* on June 28th, 1884, as follows: "To each 5 cc. of urine, neutral or faintly acid, add 2 drops of a saturated solution of potassium iodide, thoroughly mixing, then add 4 or 5 drops of a solution of the acid nitrate of mercury." If peptone is present the precipitate thrown down will be yellow, if not it will be a brilliant red.

Among the proposed tests for the presence of albumen in the urine it is necessary to make a distinction between those which are of value for use at the bedside and those which are more appropriate to the laboratory.

Bedside Tests.—A pellet of compressed potassium ferrocyanide dropped into urine which has been previously acidulated by a pellet of citric acid gives a distinct precipitate when albumen is present. This test has been perfected by Dr. Pavy, who claims for it that it does not indicate the presence of peptone. All that is required is a small test tube into which, for convenience of carriage, can be slipped a double tubular box containing the pellets. It is necessary to allow a moment or so to elapse before

deciding that the cloudiness which first appears is albuminous. Such cloudiness is sometimes formed by minute gaseous bubbles derived from the pellets.

Another very convenient bedside test can be carried out by allowing a drop of urine and a drop of nitric or saturated solution of picric acid to meet on a thin microscopical cover glass. When this is done and the glass is held over the dark coat sleeves if there is albumen present a line of white cloud will be plainly discernible along the junction of the two fluids. This test is very delicate. The whole apparatus required is a thin cover and a capillary tube containing the reagent. In the absence of this latter by holding the thin cover with a drop or two of urine on it near enough to a candle or wax vesta flame to cause a deposit of soot on the under surface the presence of albumen in the urine may be detected by simply allowing the urine on the upper surface to boil, its presence being indicated by the white cloudiness produced and contrasting with the black colour of the glass.

Test papers saturated with various reagents are also of great convenience for bedside purposes.

Dr. George Johnson for the same purpose drops a crystal or two of picric acid into the urine, this reagent causing an immediate precipitation of albumen if such substance be present in the specimen examined.

Laboratory Tests.—Dr. Pavy's pellets, or Dr. George Johnson's picric acid crystals, are either of them equally available in the laboratory, as indeed is the thin glass cover. For the more deliberate and careful examination of the urine, it is, however, better to use a saturated solution of picric acid. When this is added to urine in a test tube it constitutes a very delicate test. It can be used in two ways. Owing to the slight difference in the specific gravity of the solution of picric acid and of the urine, it requires some care to add the picric acid to the urine so as to form a supernatant layer, but if this is done, minutest traces of albumen when present will be indicated by the haziness produced at the line of junction. Or by using a wide-mouthed test-tube, and allowing the saturated solution to fall drop by drop upon the surface of the urine, the presence of albumen will be indicated by the appearance of clouds formed where the two liquids mingle. A peculiarity about the saturated solution of picric acid is that it forms a rough quantitative test for albumen. The first few drops of the reagent added may not give indications of the presence of albumen, or may only slightly do so, but if the process is continued the reaction becomes more

marked, and by adding sufficient saturated solution of picric acid all the albumen present may be precipitated. So that for purposes of rough comparison between different specimens of urine it may be said that the more albumen present the less of the saturated solution is required to produce a permanent precipitate, and *vice versâ*.

Besides those above mentioned, the brine test, as it is called, is in general use. One part of hydrochloric acid mixed with twenty parts of water, and the mixture saturated with common salt, constitutes the reagent to be employed. In consequence of the high specific gravity of this fluid, it can by sloping the test-tube containing the urine, and pouring it carefully down the side of the tube, be easily made to sink through the urine without mixing with it, but forming a distinct layer beneath it. If albumen, either of serum or peptone, be present in the urine, at the line of junction of the two fluids there will appear a cloudiness. Such tests as the above are all very well when the urine is clear to begin with, but when this is not the case, they are when used cold of little value.

The ferrocyanide test must not be used with heat, as the reagent is thereby decomposed. It is true that many urines may be cleared by the application of a gentle heat, and the reagents used as when it is cold. But the saturated solution of picric acid, or the crystals of that substance, are available with heat. In fact, there is an advantage in boiling the urine after this reagent has been added to, as in case albumen has been indicated the application of heat renders the fact of its presence absolutely certain, and no alteration of the colour takes place. Besides this the use of picric acid in this manner has another advantage to be noticed further on in relation to detection of sugar.

Albumen may be present in the blood from other causes than the mingling therewith of blood serum, Pus and blood in the urine will each of them cause albuminous reaction, the former of these must be detected by the microscope, the later can be detected chemically as well.

2. BLOOD.

The presence of blood in the urine may be apparent from the colour varying from reddish to dark coffee colour. Or it may be determined either microscopically or chemically.

Microscopically.—Blood corpuscles are of course readily detected, but the mere detection is not always sufficient, it is of great importance in some cases to decide from what part of the urinary tract the blood has come. This can be done by noticing the condition of the corpuscles. If they are crenated or have lost their clearly defined edges, if they are

in cast-like bundles, if they are contained in casts, it may be argued that they have come from the kidney. The crenation of their edges is due to the action of the urine in which they have been steeped since their extravasation. It is therefore possible for them to acquire this appearance when they have been detained in the bladder in cases of retention, having escaped from the vessels in that organ. But in that case there will be other blood corpuscles present normal in shape from more recent extravasation, for it is not likely that only a few would escape and then the bleeding cease. The hæmorrhage is pretty certain to be continuous in this locality.

Chemically.—The presence of blood in the urine is demonstrated by the detecting therein of hœmo-globin.

To test for this substance it is necessary to add to the urine in a test tube five drops of tincture of guaiacum and then to float upon it a small quantity of ozonic œther, at the line of junction of the two fluids, if there be any hœmo-globin present a blue tint will appear.

Some white blotting paper soaked with the urine will show the same coloration on the addition of the œther and tincture of guaiacum. Some resemblance to the colour thus produced is produced when there is iodide of potasseum present in the urine as is the case when patients are taking that drug. The genuine hœmo-globin blue is more purely blue, there is some yellow mingled with the blue in the other case, and the iodide colour is much less rapid in appearance.

(3) SUGAR.

In the *Lancet* (March 1st, 1884) Dr. Pavy published a method of testing urine for sugar, and of determining the amount of that substance present. The following description thereof is given in his own words :

"The solution is made by dissolving 20.400 grammes of potassic sodic tartrate with the same amount of caustic potass, then adding a solution of 4.158 gramme of cupric sulphate. When this mixed solution is quite cold, add 300 cc. of strong solution of ammonia (.880), and with water, make up to one litre. Ten cubic centimetres of the above liquid is a convenient quantity to work with, and does not call for the employment of any appliance to obviate the inconvenience arising from the evolved ammonia as I found to be necessary when I first introduced the test, and used a larger amount for the analysis. By diluting the specimen to be examined to a greater extent, as much accuracy is attainable as with the employment of a larger amount of the test, and a less dilute liquid. In

performing the analysis, twice the volume of water is added to the 10 cubic centimetres of test employed. The ten cubic centimetres of the ammoniated cupric test are decolourised by, and therefore stand equivalent to, .005 grm. of glucose.

Application of the Test.—The apparatus required consists of a burette and a glass flask of about 150 cubic centimetres capacity, supported on a stand. The graduation on the burette is into 20 cubic centimetres, and each centimetre is divided into tenths. Instead of a spring clip, as is usually employed under such circumstances, to regulate the dropping of fluid from the burette, a screw arrangement is provided by which the flow is susceptible of being governed with mechanical precision. The cubic centimetre measure may be used both for measuring out the test liquid and for diluting the urine. It gives sufficiently near measurement for clinical purposes, but a pipette would be employed by the chemist. Pipettes are, however, not so easily managed by those who are not engaged in laboratory work. The 100 cubic centimetre flask employed for diluting the urine and a spirit lamp or gas burner complete the apparatus. On account of the delicacy of action belonging to the test the specimen to be examined requires to be extensively diluted if containing a significant amount of sugar. With moderately strong saccharine urine dilution to the extent of 1 to 20 is found to be a convenient point. When very highly saccharine, 1 in 40 may be desirable, and when only slightly saccharine, 1 in 10. The dilution should be such as to render from about 3 or 4 up to about 7 or 8 to 10 cubic centimetres required to discolourise the 10 cubic centimetres of the test. For the dilution, either 5, $2\frac{1}{2}$, or 10 cubic centimetres (according as it is desired to dilute to 1 in 20, 1 in 40, or 1 in 10) of the specimen are measured out in the small cubic centimetre measure glass, and poured into the 100 cubic centimetres flask. The flask is then filled with water to its measure line, the cubic centimetre measure glass having been rinsed out into it with some of the water employed. After being shaken and thoroughly mixed the contents of the flask are poured in the burette, and a little allowed by the screw clip to run out, in order that the tubing below may be filled.

The 10 cubic centimetres of the test liquid are now measured out and placed in the flask intended to be attached to the burette. When placed in the flask, 20 cubic centimetres of water are added, and by the water thus used the cubic centimeter measure is rinsed out. Ordinary water will do, unless highly impregnated with

lime. Distilled or rain-water gives a liquid yielding a more sharply defined result. The flask is now affixed to the cork belonging to the burette, and heat from a spirit lamp or gas burner applied underneath. When its contents have well commenced to boil, the screw which governs the flow from the burette is turned so as to allow the liquid to escape by drops, at the rate of about 60 to 100 per minute, according to the effect produced upon the colour of the test. What is wanted is a gradual advancing decoloration, until the contents of the flask are brought to the colourless state of water; and towards the end, the dropping has to be conducted more slowly than at first, so as to avoid going beyond the exact point required. When this point is attained, the screw is turned to stop the further flow. The level of the liquid in the burette having been read off before starting, a second reading at the termination gives the amount of the liquid being examined which has been required to decolorise the 10 cubic centimetres of the test, and which thus contains 5 milligrammes of glucose.

If in performing the analysis the contents of the burette are dropped in too slowly, and the boiling becomes too prolonged, the suboxide falls in consequence of the dissipation of ammonia, before the opperation is completed. Should this event occur, a fresh analysis must be performed, and the contents of the burette dropped in a little more quickly. If suboxide has collected upon the surface of the flask it must be removed with a little nitric or other mineral acid, for a dirty flask tends to promote the depositions of suboxide before it would otherwise occur. The chief precautions, it may be said, to observe are not to drop in from the burette with sufficient rapidity to run the risk of passing beyond the point required for decoloration, and at the same time not to drop in so slowly as to lead to a deposition of suboxide from the expulsion of the ammonia. With everything conveniently at hand a few minutes only are required for the performance of the analysis from beginning to end. It is easy for anyone to convince himself of the delicacy and reliability of the test by examining two specimens containing different amounts of sugar, and then mixing them together in equal quantities, and examining the mixture. The amount of sugar in the mixture will be the mean of the two specimens, and this, the analysis of the mixture, will be found with striking closeness to reveal, if the analyses have been properly and carefully performed.

The analysis having shown the quantity of the contents of the burette required to decolorise the 10 cubic

centimetres of the test, and therefore containing 5 milligrammes of glucose, it now only remains by a simple rule of proportion calculation to bring the expression to any form desired. There are reasons to render it advisable that the expression should be given as parts per 1 000, and it would be convenient if this plan, agreeing with what is done on the Continent, were universally adopted in this country. Suppose 4 cubic centimetres constituted the amount of diluted urine required to decolorise the contents of the flask, then—

$$\text{as } 4 : .005 :: 1000 : 1.250$$

$$\text{or } \frac{.005 \times 100}{4} \text{ or } \frac{5}{4} = 1.250$$

To save the trouble of calculation the following table may be consulted [*vide Table I*]. It gives for cubic centimetres required to decolorise the quantity of sugar in parts by weight per 1000 by volume. All that is necessary after the analysis has been completed is to look against the number of cubic centimetres required to decolorise, and the quality of sugar per 1000 is found expressed.

It must be remembered that the quantity here expressed represents that which exists in the liquid examined. This liquid consisted not of the urine itself, but of diluted urine, and the figures must be multiplied according to the extent to which the dilution was carried. For instance, with 5 cubic centimetres of urine and water to 100 cubic centimetres, the figures must be multiplied by twenty; with 2.5 cubic centimetres of urine and water to 100 cubic centimetres, by forty; and in like manner for other proportions."

The table given is slightly modified from Dr. Pavy's as the "grain per ounce" column was not given in the original table, but the column has been found useful when it has been found necessary to calculate the amount of sugar passed in any given twenty-four hours. This process requires great care in regulating the flow of the urine from the burette. If it go to fast more than is required to destroy the blue colour will be employed; and if too slow the liquid boiling in the flask becomes decomposed before the proper amount of urine has reached it. This is really the only drawback to this test, and it is one which practice will easily remove.

Another test for sugar was described in the *British Medical Journal* January 5th, 1883, by Dr. Geo. Johnson. It consists in the use of picric acid and liq. potassæ. For rough qualitative examination of urine, all that is

TABLE I.

Table showing the Amount of Sugar Expressed in Parts (by weight), per 1000 (by volume) and in grains per ounce, corresponding with Cubic Centimetres in 10ths, required to decolourize 10 c.c. of the Ammoniated Cupric Test.

Cubic Centimetres to Decolourize.	Parts per 1000.	Grains per ounces.	Cubic Centimetres to Decolourize.	Parts per 1000.	Grains per ounce.	Cubic Centimetres to Decolourize.	Parts per 1000.	Gains per ounce.	Cubic Centimetres to Decolourize.	Parts per 1000.	Grains per ounce.	Cubic Centimetres to Decolourize.	Parts per 1000.	Grains per ounce.
1.0	5.000	2.1875	4.0	1.250	.5468	7.0	.714	.3125	10.0	.500	.2187	13.0	.384	.1675
.1	4.545	1.988	.1	1.219	.5336	.1	.704	.3080	.1	.495	.2165	.1	.381	.1669
.2	4.166	1.8226	.2	1.190	.5218	.2	.694	.3038	.2	.490	.2144	.2	.378	.1657
.3	3.846	1.6826	.3	1.162	.5087	.3	.684	.2999	.3	.485	.2123	.3	.375	.1643
.4	3.571	1.5623	.4	1.136	.4971	.4	.675	.2956	.4	.480	.2103	.4	.373	.1633
.4	3.333	1.4518	.5	1.111	.4861	.5	.666	.2916	.5	.476	.2082	.5	.370	.1620
.6	3.125	1.3671	.6	1.086	.4755	.6	.657	.2870	.6	.471	.2063	.6	.367	.1608
.7	2.941	1.2866	.7	1.063	.4654	.7	.649	.2840	.7	.467	.2044	.7	.364	.1592
.8	2.777	1.2149	.8	1.041	.4556	.8	.640	.2804	.8	.462	.2021	.8	.362	.1583
.9	2.632	1.1514	5.9	1.020	.4464	.9	.632	.2768	.9	.458	.2003	.9	.359	.1570
2.0	2.500	1.0937	.0	1.000	.4375	8.0	.625	.2734	11.0	.454	.1986	14.0	.357	.1561
.1	2.380	1 04	.1	.980	.4289	.1	.617	.2700	.1	.450	.1961	.1	.354	.1550
.2	2.272	.997	.2	.961	.4206	.2	.609	.2668	.2	.446	.1953	.2	.352	.1540
.3	2.173	.950	.3	.943	.4127	.3	.602	.2635	.3	.442	.1935	.3	.349	.1529
.4	2.083	.911	.4	.925	.4050	.4	.595	.2604	.4	.438	.1916	.4	.347	.1519
.5	2.000	.875	.5	.909	.3977	.5	.588	.2573	.5	.434	.1902	.5	.344	.1508
.6	1.923	.841	.6	.892	.3906	.6	.581	.2543	.6	.431	.1885	.6	.342	.1499
.7	1.851	.789	.7	.877	.3835	.7	.574	.2512	.7	.427	.1869	.7	.340	.1487
.8	1.785	.780	.8	.862	.3771	.8	.568	.2485	.8	.423	.1853	.8	.337	.1474
.9	1.724	.754	.9	.847	.3707	.9	.561	.2457	.9	.420	.1829	.9	.335	.1456
3.0	1.666	.728	6.0	.833	.3645	9.0	.555	.2430	12.0	.416	.1820	15.0	.333	.1455
.1	1.612	.705	.1	.819	.3586	.1	.549	.2402	.1	.413	.1807			
.2	1.562	.683	.2	.806	.3528	.2	.543	.2375	.2	.409	.1793			
.3	1.515	.662	.3	.793	.3472	.3	.537	.2352	.3	.406	.1778			
.4	1.470	.643	.4	.781	.3417	.4	.531	.2327	.4	.403	.1764			
.5	1.403	.626	.5	.769	.335	.5	.526	.2302	.5	.400	.1755			
.6	1.388	.607	.9	.757	.3314	.6	.520	.2275	.6	.396	.1736			
.7	1.353	.591	.7	.746	.3266	.7	.515	.2255	.7	.393	.1720			
.8	1.316	.575	.8	.735	.3216	.8	.510	.2232	.8	.390	.1708			
.9	1.281	.560	.9	.724	.3170	.9	.505	.2210	.9	.387	.1695			

required is to take the specimen of urine which has been previously tested for albumen by the addition of picric acid and boiling, and to add thereto a small quantity of liq potassæ and repeat the boiling. If, after thorough boiling, the liquid remains in the least degree translucent it may be concluded that there is no amount of sugar present in the urine that need cause uneasiness. All urine contains some sugar, but it is only when it becomes excessive and other symptoms are present that we need notice it. As much as five grains to the ounce of urine is not incompatible with health. Should, however, the fluid be opaque it will be advisable to apply a quantitative test. Dr. Johnson recommends the following in the paper above alluded to. The following solutions are required for use :

(1) *Solution of ferric acetate* equal in tint to that yielded by a solution of sugar containing 1-4th gram to the fluid ounce. The following is the formula for the standard solution :

℞ Liq. ferri. perchlor fort..... ℥ i.
Liq. ammon. acet .. .. ℥ iv.
Acid acet. glaciale ..... ℥ iv.
Aquæ dest. ..... ℥ ijss.

(2) *Saturated solution of picric acid.*

(3) *Liquor potassæ, B.P.*

The apparatus (sets of which are made by E. Cetti, 36, Brook Street, Holborn, W.C.) required are as follows :

(1) *The Picro-saccharimeter.*

(2) *A long test tube* graduated at the lower end into four divisions, each equal to one fluid drachm.

(3) *Two flat-bottomed tubes*, each about six inches long and one inch in diameter.

(4) *A flask for dilution* graduated to 50 cubic centimetres.

(5) *A 10cc. measure.*

Measure out one fluid drachm of urine into the long test tube. Add thirty minims of liq. potassæ and eighty minims of saturated solution of picric acid. Make up to four drachms with water. Heat over a spirit or gas lamp and keep the liquid boiling for *sixty seconds by the watch.* Cool by dipping the tube in cold water, and ascertain that the cold liquid measures exactly four drachms, if less, make up with water, if more, boil and evaporate down to four drachms. If the colour of the boiled liquid is the same as that of the ferric acetate solution or paler the urine containes one grain of sugar to the fluid ounce or less. Should the colour be darker than the ferric acetate standard solution, introduce the boiled liquid into the graduated tube of picro-saccharimeter till its level stands at ten

divisions, while the stoppered tube contains the ferric acetate standard solution. Now dilute the dark red liquid in the graduated tube with water till the colour is nearly equal in tint to that of the standard in the adjacent tube. Confirm the identity of the tints by transferring some of the diluted liquid to one of the flat-bottomed tubes, of which it should be made to fill about one inch in height, and comparing with an equal depth in the standard solution by looking through the two liquids upon a piece of white paper in a good light. The tints being identical transfer again to the saccharimeter and read off the level of the liquid. Each division above 10 = 0.1 grains per fluid ounce: thus 13 divisions = 1.3 grains per fluid ounce, 30 divisions = 3 grains per fluid ounce, etc., etc. If more than eight grains per fluid ounce is indicated dilute another portion of the urine ten times by delivering 5cc. from the measure into the 50cc. diluting flask and filling up to the graduation mark with water and repeat the analysis as before, employing sixty minims of the picric acid solution. In this case each division on the saccharimeter above 10 divisions indicates one grain of sugar per fluid ounce: thus, dilution from 10 up to 58 divisions indicates that the urine contained fifty-eight grains to the fluid ounce.

There is a slight drawback to this test in that the colour produced by an undiluted specimen of urine which contains anything over five or six grains of sugar to the ounce and that produced by a diluted specimen containing about ten grains to the ounce are very similar, so that if in examining an undiluted specimen we find it necessary to dilute it over the division marked 60 we cannot be sure of our result. Dr. Johnson recognizes this in advising that if the urine contains over eight grains to the ounce, that it requires dilution above the 80th division, it should be diluted and tested again, but he fixed the limit for this necessity too high: experience shows that he should have put it at the figure 60.

(4) OXALIC ACID.

This substance is found in urine in the form of calcium oxalate. Although this salt is present in a greater or less degree in the vast majority of urines it cannot be regarded as a normal constituent. Its presence is said to be due to a deficient oxidation of organic material. It may be detected and the amount estimated by the use of phenol-phthalein and caustic soda. On the addition of caustic soda to a solution of phenol-phthalein a red colour is developed, but if oxalic acid is

present the colour is destroyed until the acid is saturated by the soda. A test has therefore been arranged as follows: A decinormal solution of caustic soda is made by diluting one part of the B.P. volumetric solution with nine parts of water. Each part of this solution thus formed will be equivalent to or will saturate .0063 parts of oxalic acid. A solution of phenol-phthalein in rectified spirits of wine, 0.3 per cent. in strength. This is made by dissolving 0.3 parts in 100 parts of spirits of wine. To apply the test ten parts of the urine to be examined are placed in a shallow vessel of white porcelain. A few drops of the solution of phenol-phthalein are added. The decinormal solution is then added drop by drop until the red colour formed fails to disappear on agitation. The amount of the decinormal solution used is then measured. This is done by means of a graduated tube marking minims, half drachms, or cubic centimetres. As each part of the decinormal solution is equivalent to .0063 parts of oxalic acid the parts per thousand of the abnormal salt in the urine may be obtained by multiplying the number of parts of the decinormal solution used by 0.63. By multiplying this result by .4375 the grains per ounce can be obtained.

Table showing the amount per 1,000 *for every five parts of the decinormal solution.*

1 part	= .63	per 1,000	5 parts	= 3.15	per 1,000
1.5 parts	= .94	,,	5.5 ,,	= 3.46	,,
2 ,,	= 1.26	,,	6 ,,	= 3.77	,,
2.5 ,,	= 1.62	,,	6.5 ,,	= 4.08	,,
3 ,,	= 1.89	,,	7 ,,	= 4.39	,,
3.5 ,,	= 2.20	,,	7.5 ,,	= 4.70	,,
4 ,,	= 2.52	,,	8 ,,	= 5.01	,,
4.5 ,,	= 2.83	,,	8.5 ,,	= 5.32	,,

(VI) THE CHARACTERISTICS OF THE DEPOSIT, BOTH MACROSCOPIC AND MICROSCOPIC.

As regards the former of these characteristics, the macroscopic appearance of the deposit, not very much is to be learnt from this, but it is of importance to notice the colour, as that sometimes betrays the nature thereof, as in the case of the cayenne pepper grains of uric acid, the red of blood, etc. It should also be noted whether the deposit is heavy and falls close and quickly, as oxalate of calcium does when in excess, or whether it is light and flocculent like pus.

As regards also the microscopic appearances there is little to be added to what is already well known. A certain amount of care in adjusting the light, the discriminate use of object glasses of different powers are all facts within the knowledge of all who are in the habit

of working with the microscope. There is, however, one method of procedure with regard to microscopical examination of urinary deposits which is very useful, particularly where casts are suspected. This consists in adding to the drop of urine on the slide a drop of a solution of aniline blue and waiting for a few minutes. On examination it will be found that this dye has fixed all the colloid organic portions of the deposit, leaving the crystalline and granular parts unaffected. It is particularly useful for detecting the fine hyaline casts, and enables one to discriminate between the rouleaux of amorphous urates and granular casts.

In recording the observations made in the examination of urine, it is useful to have the observations so arranged as to be readily consulted as references. Books ruled as follows are very useful for this purpose [*vide Table II*].

TABLE II.

No.	Date.	Name and Age.	Amount in ounces passed in 24 hrs.	UREA.			SUGAR.			Albumen.	Oxalic Acid parts per 1000.	Reaction.	Sp. Gr.	Colour.	Characters of Deposit.		Complaint and Remarks.
				Parts per 1000	Grains per ounce	Total in 24 hours	Parts per 1000	Grains per ounce	Total in 24 hours						Macroscopic.	Microscopic.	